NERRS Science Collaborative
Progress Report for the Period 09/01/13 through 03/07/14
Project Title:
Sustaining Coastal Landscapes and Community Benefits:
Developing an Interdisciplinary Model for Enhancing the Impact of NERRS Science
Submitted March 7, 2014

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Project Research Team
This interdisciplinary team designs and conducts economics, ecological and
communication research in collaboration with stakeholders.
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Project start date: Fall 2010

Report compiled by: Christine Feurt and Project Research Team
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Contributing team members and their role in the project:
See above for Wells NERR Science Collaborative Team and Project Research Team
composition

Wells NERR Stakeholder Network These 18 organizations participated in the
development of the proposal. Representative members of the network interacted with
the Wells NERR or Project Research Team during this reporting period to provide
feedback on research progress and incorporation of results in conservation,
management and planning.
1. Maine Association of Conservation Commissions
2. Maine Geological Survey
3. Maine Coastal Program
4. Maine Nonpoint Education for Municipal Officials (NEMO)

5. Maine Sea Grant
6. Maine Drinking Water Program
7. Maine Department of Inland Fisheries and Wildlife, Beginning with Habitat
8. Maine Department of Environmental Protection
9. Maine Department of Marine Resources
10. Southern Maine Regional Planning Commission
11. Mt A to the Sea Conservation Initiative
12. Rachel Carson National Wildlife Refuge
13. University of New England
14. Laudholm Trust
15. Piscataqua Region Estuaries Partnership
16. Town of Wells, Planning Department
17. Town of Sanford, Planning Department
18. Town of Kennebunk, Conservation and Open Space Planning Committee & Planning Department
19. Kennebunk, Kennebunkport and Wells Water District (engaged in project activities during this period, was not a part of the original proposal)
20. U Maine Sustainability Solutions Initiative (engaged in project activities during this period, was not a part of the original proposal)
21. New England Sustainability Consortium (NEST) (engaged in project activities during this period, was not a part of the original proposal)
22. Maine Aquatic Resources Management Strategy (ARMS) Group
23. Mousam Kennebunk Rivers Alliance

A. **Progress overview**:

Overall Goal of Project
The proposed project will develop and apply an integrated, spatially explicit, transdisciplinary framework to characterize and quantify the impact of riparian management on ecosystem services identified as important by Wells NERR stakeholders - including land use decision makers, planners and policymakers at state and municipal governmental scales and partner NGOs. Building on ecological models and data available for the Merriland River and Branch Brook watersheds adjacent to the Wells NERR, the project will coordinate economic expertise in ecosystem service valuation with Wells NERR expertise in ecological science to provide defensible estimates of social benefits associated with riparian area management in the Wells NERR region, as realized through changes in ecosystem services.

Quantification of values and tradeoffs associated with management alternatives will provide information crucial for policy design and to identify often overlooked benefits of policies to enhance ecosystem sustainability. Integrated components of the proposed project will ensure that science-based results are applied effectively to inform coastal management and land use decisions and that the results are transferrable to other Reserves. Outputs will provide heretofore unavailable mechanisms through which NERRS ecological data can be integrated with economic data and used in coordination with stakeholders to inform coastal management that sustains ecosystem services associated with riparian areas.

Overall Project Objectives
I. Develop a user-inspired, transdisciplinary model to guide sustainable riparian management in the Wells NERR and surrounding watersheds, grounded in geo-spatially explicit quantification of ecological/economic tradeoffs in ecosystem services and values.

II. Coordinate social science and cognitive theory, principles of effective communication, local motivations for stewardship/conservation, and approaches for social learning to:
   a. Identify specific stakeholders most influential in affecting decisions, management and policy change affecting Wells NERR riparian areas addressed in Objective I.
   b. Evaluate Wells NERR communication approaches to these identified stakeholders/stakeholder groups to assess the degree to which messages are in alignment with values and priorities identified in Objective I;
   c. Develop high impact, science-based communication strategies and decision support tools—based on the ecological/economic results of Objective I—to inform integrated management of riparian area land use, habitat and nonpoint source pollution in watersheds draining into the Wells NERR region.
III. Engage Wells NERR stakeholders, the Science Collaborative Team and the Project Research Team within a collaborative learning process to build long-term institutional and regional capacity for improved riparian management through a community of practice. Collaborative learning will be grounded in coordinated science, communication and decision support outputs of Objectives I and II.
IV. Based on results of prior objectives, develop transferable templates for application of developed methods to guide policy development and stakeholder interactions in other Estuarine Reserves. Integrate with NERRS/NOAA to assist in broader adoption.

Focus of Objectives for the period September 2013 – August 2014
Note: A no-cost extension has been granted for the period August 2013 - August 2014. Goals for Quarters 3 & 4 for Year 3 will be carried over into year 4.

Project Timeline Highlighted for this Reporting Period

Objectives, Products, Activities	Year 1					Year 2					Years 3 & 4			
	Q1	Q2	Q3	Q4		Q1	Q2	Q3	Q4		Q1	Q3	Q3	Q4
Objective I: Develop Models Quantifying Ecosystem Services and Values	x	x	x	x		x	x	x	x		x	x	x	x
Objective I: Develop, Test and Implement Choice Experiment; Conduct Ecological Field Campaigns; (Implement Choice Experiment next period)			x	x		x	x	x	x		X	x	x	x
Objective I: Data Analysis and Results for Ecological/Economic Models						x	x	x	x		x	X	x	x
Objective II: Communications Audit		x	x	x		x	x	x	x		x	x	x	x
Objective II: Mental Models and Test Cases				x		x	x	x	x		x	x	x	x
Objective III: Develop Community of Practice	x	x	x	x		x	x	x	x		x	x	x	x
Objective IV: Develop/Disseminate Decision Support Tools and Transfer Mechanisms											x	x	x	x
Objectives I-IV: Coordinate with Stakeholders	x	x	x	x		x	x	x	x		x	x	x	x

B. Working with Intended Users: Presentations, outreach and engagement about the project, ecosystem services, and collaborative interdisciplinary research.

Interaction with intended users/stakeholders during this period is described below. The collaborative team for this project engages with stakeholders at conferences, workshops, field-based trainings, meetings and as members of on-going partnerships such as the

Salmon Falls Watershed Collaborative, the Mount Agamenticus to the Sea Conservation Initiative, the UNE Center for Sustainable Communities, the Maine Sustainability Solutions Initiative, the New England Sustainability Consortium (NEST) and the Sustain Southern Maine Partnership.

Members of the Wells NERR Collaborative Science Team including Christine Feurt and Annie Cox are actively engaged in the Salmon Falls Watershed Collaborative through monthly conference calls, field trips, trainings and meetings. This partnership of governments, watershed groups, land trusts and water supply agencies includes key intended users for the results of this project. The innovative work of the Collaborative focuses on five action strategies for sustaining watershed ecosystem services.

Annie Cox represented the Wells NERR at Mobilize Maine Regional Meetings and the HUD Sustainable Communities "Sustain Southern Maine" project during this period. This is an economic development initiative for southern Maine business leaders, academics, local governments and NGOs focusing on sustainability, quality of place and economic development. Representatives for southern Maine businesses, financial organizations, municipal government and NGOS are part of this working group.

The stakeholder network for this project participates regularly in events sponsored by the Wells NERR Coastal Training Program and in on-going research and stewardship projects of the Wells NERR such as the *Mousam and Kennebunk Rivers Alliance*, the *Restoring Stream and Habitat Connectivity in Branch Brook* project and a state sponsored partnership for aquatic resource management called *ARMS*. These three partnerships were not recognized in the original proposal in 2010 but have emerged as important end users of research findings about communicating riparian buffer ecosystem services and ecosystem service valuation. The Wells NERR is already linked to these groups through members of the ecological team.

The NERR system itself is a primary end user for this project. A NSC Transfer project, *Bridging the Gulfs*, incorporated the communications audit, mental models and collaborative learning aspects of the project. This transfer project will be executed in collaboration with Mission Aransas NERR to develop, implement and evaluate two system wide trainings to be delivered in September 2014 in Maine and January 2015 in Texas. Curriculum development will being in March 2014.

An evolving NERRS workgroup focusing on Ecosystem Service Valuation met during the NERRS Annual Meeting in November 2014. The members of the workgroup are interested in building capacity within the system for interdisciplinary research and exploring benefits of organizing NERRS programs within an ecosystem services framework.

Diverse stakeholder engagement events provide opportunities for building trust, creating awareness of the project and staying current on organizational priorities to maintain the relevance of the project and increase the potential for transfer of research findings. Formal evaluations, meeting minutes, participant observation and individual conversations with people in the activities listed above provided input into the project. Members of the project teams use these regular stakeholder interactions to guide the project, build trust and create new partnerships. Members of the Wells NERR research team are working in the Branch Brook watershed to restore fish passage. Outreach for this project has engaged key restoration stakeholder audiences.

Interactions with ecological and social scientists as intended users

Feurt, DeLauer and Wilson will present a dedicated session to the Conference on Ecological and Ecosystem Restoration in New Orleans in July 2014, see Appendix II for details.

Formal Conference Presentations to Professional Audiences

Feurt, C. 2014. *Ecosystem Services and Human Well Being - Interdisciplinary Research to Increase the Impact of NERRS Science*. Presentation to Social Coast Forum February 20, 2013. Charleston, SC. 45 participants

Johnston, R. 2014. *Economic Tradeoffs in New England Coastal Management: Development, Adaptation and Ecosystem Services Presented at the Coastal State Lecture Series. February 25, 2014. University of Rhode Island.*

Johnston, R. 2014. *Quantifying Economic Advantages of Riparian Restoration* Presented March 12, 2014 at the *Current Stormwater Concerns and Solutions Workshop. Worcester Polytechnic Institute, Worcester, MA*.

Informal Presentations to key stakeholders about Ecosystem Service Valuation Methodology and the interdisciplinary model of the project.

> *Ecosystem Services and Human Well Being*
> *Interdisciplinary Research to Increase the Impact of NERRS Science*
> November 21, 2013. NERRS Annual Meeting Shepherdstown, WV

> *Nobody Said This Would Be Easy –*
> *Modeling Collaborative Research & Lessons Learned*
> November 20, 2013. NERRS Annual Meeting, Shepherdstown, WV

C. Progress on project objectives for this reporting period

Progress is reported in this section according to Objective and Tasks. During the reporting period project team members met monthly either through face to face meetings and conference calls.

Objective 1. Develop a user-inspired, transdisciplinary model to guide sustainable riparian management in the Wells NERR and surrounding watersheds, grounded in geo-spatially explicit quantification of ecological/economic tradeoffs in ecosystem services and values.

Task I.1. Develop Ecological Scenarios and Characterize Biophysical Status, Trends and Responses.

<u>Wells NERR Ecology Team Project Update</u>**:** September 2013 – March 2014
Prepared by Kristin Wilson, Jake Aman, Tin Smith and Chris Peter
(Please see Appendices at the end of this report in addition to the section below)

The overall goal of the ecology portion of this project is to determine the influence of forested riparian buffer on aspects of stream ecology – specifically nitrate and ammonium inputs and water column concentrations; water temp, pH, turbidity and level; algal cover on substrates; stream macro invertebrates; in-stream fish habitat, in-stream flows, and fish. This section outlines grant activities related to biological monitoring and stream habitat assessment. Also included are issues, solutions, remaining questions, and next steps.

Task I.1

During this project period, resin bags were collected, processed, sent to the University of Maine's Soil Analytical Laboratory for NH4 and NO3 analyses, and the results from these were received by the Wells NERR in October 2013. Fluorometric analysis of periphyton samples was completed in September 2013. All other 2013 field data have been digitized and quality controlled during this project period. All QA/QC notes are attached in Appendix I.

The Wells NERR sent the 2013 macro-invertebrate samples to a certified taxonomic laboratory for species identification in September 2013. A status update at the end of January 2014, indicated that results from these analyses will be completed by mid- to late-February 2014. This is later than the projected completion date and has delayed data analyses, including generation of a 2013 Index of Biotic Integrity for impacted and reference sites and inter-annual comparisons of the entire data set.

The Wells NERR signed a continued contract with Chris Peter (the Stream Ecologist consultant hired through an RFP process to analyze the 2011 and 2012 data) to analyze the 2013 data and to complete inter-annual comparisons of 2011, 2012, and 2013 data. His progress on the 2013 data has been stalled waiting on the macro-invertebrate data, although he has started preliminary analyses of other biophysical data. Data analyses will be conducted in the same manner as with 2011 and 2012 data.

In January 2014, the ecological team submitted an abstract to the 2014 Conference on Ecological and Ecosystem Restoration in New Orleans, LA in July 2014 (Appendix II). The ecological team plans on submitting two more abstracts in March 2014 to the Maine Waters Conference (in April) and the New England Estuarine Society (in May).

Task I.2. Characterize Linkages between Ecological Outcomes, Ecosystem Services and Values. (nothing to report this period)

Task I.3 Develop Models for Estimation of Ecosystem Service Values and Tradeoffs.

All underlying models for estimation of ecosystem service values and tradeoffs have been completed, and are awaiting data from the choice experiment surveys for final estimation.

Task I.4. Develop and Test Choice Experiment Surveys.

Since March 1, 2013, all choice experiment surveys and other survey implementation materials have been finalized and reviewed, based on the theoretical models and ecological data developed previously. This involved a collaborative process that included participation of economists, ecologists, resource managers, natural scientists, and members of stakeholder groups. As informed by the model above, the developed choice experiments present survey respondents with voting-type choices between multi-attribute policy options, in this case for riparian area management in the MBLR watershed.

Each choice is described by indicators of ecosystem services developed and refined in prior research phases, along with other relevant attributes. That is, surveyed households are presented with multi-attribute policy choices, similar to public referenda, that allow them to choose among policies with different effects on quantities, qualities and uses of ecosystem services (as forecast by ecological model components), along with attributes of the policy process required to provide those ecological outcomes. Observed choices over many sets of options enables choice probability to be modeled as a function of attribute levels and the estimation of preferences, tradeoffs and values, as summarized by the theoretical model above.

Prior to presenting choice questions, the surveys provide information that:
(i)   describes the status of and services provided by riparian land in the MBLR watershed,
(ii)   characterizes affected ecological systems and linkages,
(iii)   describes methods that could be used to restore and preserve riparian land and associated tradeoffs, and
(iv)   provides definitions, derivations, and interpretations for the ecological indicators used in the survey scenarios.

The survey conveys the information via a combination of text, graphics (including geographic information system maps and ecosystem representations), and photographs, all of which have been subjected to extensive pretesting with both experts and laypersons. In total, eight focus groups were used during survey design, including focus groups with both laypersons and experts.

Final survey materials were reviewed by both natural and social scientists on the research team, as well as by a group of stakeholders and policymakers in a final focus group held on April 9th at the Wells Reserve. Ecological results have been formally linked to the policy choice questions, enabling the specification of a wide range of feasible policy outcomes over which survey respondents will "vote," and through these votes reveal their preferences and values for different outcomes of riparian land restoration. Multiple survey variants will enable testing of a wide range of hypotheses related to the way that Maine residents perceive and value ecosystem services related to riparian land.

The survey design will enable quantification and testing of values (willingness to pay) related to changes in:

(a) the quantity of riparian buffer under natural vegetation quantified using a land use index,
(b) the condition of river ecology quantified using an aquatic biotic index,
(c) the abundance of recreational fish, quantified using field sampling data,

(d) the safety of water quality for swimming, quantified by government agency testing,
(e) local enforcement of riparian land development restrictions, and
(f) the size of the riparian buffer within which development and clearing is restricted.

Survey materials and related elements that have been completed include:

- Three distinct variants of the choice experiment questionnaire, designed to test specific hypotheses related to ecosystem service valuation. The first survey variant is the "baseline" survey designed to estimate ecosystem service values related to outcomes of riparian land preservation and restoration. The second survey variant is identical to the first, but includes additional information on the geographical location of each respondent relative to affected riparian land. This will enable a variety of tests related to spatial dimensions of ecosystem service values and preferences for riparian land restoration. The third survey variants illustrates a wider range of possible ecological outcomes in the policy choice questions, allowing for sensitivity analyses related to the range of possible ecological outcomes displayed in the survey booklet.
- All letters and other materials accompanying the survey booklets, including unique stationery for the survey effort including the logos of both Clark University and the Wells NERR.
- The experimental design which "mixes and matches" ecological attribute levels to create the final policy scenarios that are considered within each survey booklet. A fractional factorial experimental design was generated using a criterion that minimized D-error for a choice model covariance matrix, assuming a model with both main effects and selected two-way interactions. Profiles were screened and adapted prior to blocking to eliminate dominated and unrealistic scenarios, with the final result tested using various measures of design efficiency. The result was a design of 72 profiles (individual choice questions) blocked into 24 booklets. Blocking was conducted so as to minimize correlation between blocking structure and the underlying experimental design. The survey provides each respondent with three choice experiment questions and instructs respondents to consider each as an independent, non-additive choice.
- A bar-coded tracking procedure that enables all survey mailings and materials to be systematically tracked and linked within a single database.
- A survey implementation procedure that includes sequenced, multiple-wave mailing of (1) a preview letter, (2) the first survey and cover letter, (3) a reminder postcard, and (4) a second survey and reminder letter. The mailing sequence will be terminated for each respondent when a survey is returned.

Final Clark University Institutional Review Board (IRB) approval has been obtained for all survey materials. This includes approval for a survey response incentive that will provide a free Laudholm Trust membership to all those who return completed surveys. All survey printing, mailing and implementation steps were planned and budgeted, and production of survey materials began during fall 2013. Printing of all materials was completed by late November, 2013.

Task I.5. Develop Sampling Plan and Implement Survey.

Survey implementation took place from December 2013 through January 2014. Surveys were mailed to randomly-selected respondents in the three towns that overlap the Merriland, Branch Brook and Little River (MBLR) watershed: Kennebunk, Sanford and Wells. The sampling plan proportionally oversampled households within the watershed boundaries to ensure sufficient responses to test hypotheses related to differences in values of watershed residents versus non-residents. . Based on the size and efficiency of the experimental design, a minimum of 168 completed surveys were required for each survey variant (see above) in order to obtain sufficient sample sizes for reliable, large sample analysis. To ensure this sample size for each model, each independent survey variant was mailed to 1,272 households (3,816 households total). As noted above, multiple wave mailings and a response incentive were be used to increase response rates. (All respondents who returned completed surveys were given a free one-year membership in the Laudholm Trust.) All survey materials were bar-coded and linked to a survey database (and also linked to the experimental design database) to enable tracking and minimize the potential for mailing and data entry errors.

Formal mailing of survey materials began during the first week of December, 2013. The final round of reminder surveys was mailed on January 9, 2014. Of the 3,816 mailed surveys, 343 (9%) were returned due bad or obsolete addresses (this is an expected proportion in large scale mailings). Of the remaining 3,473 surveys that were delivered, 1,169 were completed and returned by respondents, for a net response rate of 33.6%. This is an exceptional response rate for surveys of this type. Survey data were entered and validated (i.e., double-checked) as surveys arrived, with data entry completed by February 2014.

Task I.6. Estimate Choice Experiment Models and Forecast Household Values.

 A variety of preliminary models have been specified and estimated to evaluate the data and provide initial estimates of respondents' values and their willingness to trade off different methods and outcomes of riparian land preservation and restoration. Models have been estimated using a variety of alternative specifications including conditional logit, mixed logit and latent class discrete choice models. Preliminary results appear to be largely robust to model specification.

Initial model results show evidence of good statistical fit, with all models significant at $p<0.0001$. Preliminary results indicate that residents have positive values (willingness to pay, or WTP) associated with improvements in all ecological outcomes (see list above). These are all statistically significant, most at the 1% level. Residents also have positive values for increases in development setbacks and for increased enforcement. That is, the average area resident would prefer to see larger setbacks and more enforcement. This result appears to challenge common assumptions about residents' values in southern Maine. For environmental outcomes, per percentage point increase, the highest values are associated with (a) improvements in swimming safety (the % of tests that show area beaches safe to swim). This is followed, in order, by (b) acres of riparian land with natural vegetation, (c) river ecology, or the aquatic ibi score, (c) improvements in recreational fish

abundance. However, all of these outcomes are associated with statistically significant economic benefits. Analysis will continue over the coming period to finalize models and results, and to coordinate these results with those of the ecological models presented above in order to quantify the projected benefits of alternative options for riparian land preservation and restoration.

R. Johnston will be presenting preliminary economic model results at the Coastal State Seminar Series on February 25, at the University of Rhode Island (presentation entitled "Economics of Climate Change: Tradeoffs in New England Coastal Management"). Abstracts have also been submitted to present project results at the Annual Meetings of the American Applied Economics Association (July 2014) and the Northeastern Agricultural and Resource Economics Association (June 2014).

Objective 2. Coordinate social science and cognitive theory, principles of effective communication, local motivations for stewardship/conservation, and approaches for social learning to:

a. Identify specific stakeholders most influential in affecting decisions, management and policy change affecting Wells NERR riparian areas addressed in Objective I.
b. Evaluate Wells NERR communication approaches to these identified stakeholders/stakeholder groups to assess the degree to which messages are in alignment with values and priorities identified in Objective I;
c. Develop high impact, science-based communication strategies and decision support tools—based on the ecological/economic results of Objective I—to inform integrated management of riparian area land use, habitat and nonpoint source pollution in watersheds draining into the Wells NERR region.

Task II.1. Develop and Implement Communications Audit

The mental modeling team has completed the communications audit that included seven in-depth interviews with communication professionals who work at the Wells Reserve and those who belong to partner organizations. Participants were asked about their communication strategies and goals and the ways in which they communicate about riparian ecosystem services, specifically buffers. These interviews will be used to create a representative model of what Wells and its partners think their targeted audiences should know about riparian buffers.

Task II.2. Develop Mental Models and Test Cases

Analysis of mental model data will be completed in spring 2014.

Objective 3. Engage Wells NERR stakeholders, the Science Collaborative Team and the project's Research Team within a collaborative learning process to build long-term institutional and regional capacity for improved riparian management through a community of practice. Collaborative learning will be grounded in coordinated science, communication and decision support outputs of Objectives I and II.
(See section B above)

Objective 4. Develop Decision Support Tools and Methods for Transfer

Task IV.1 Use benefit function transfer methodology to develop parameterized functions from the estimated ecological/economic models for use in other NERR's to approximate and communicate ecosystem service benefits and values based on patterns established in the Wells NERR.

Based on preliminary model results discussed above, work has now begun to develop parameterized benefit transfer functions that could be used at other NERRs to approximate and communicate ecosystem service values.

Task IV.2 Develop a template of communication tools and methodologies for Wells NERR Stakeholder Network and NERRS CTP

(not a focus of this reporting period)

D. Benefit to NERRS and NOAA
Benefits to NERRS are discussed in Section B above.

NOAA continues to expand its interest in habitat conservation and restoration, and use these efforts to better understand the benefits these ecosystems have to society.

In the latter part of 2013, the agency formalized ecosystem research as a priority area by establishing a standing Ecosystem Research Committee (a body under NOAA's Research Council). This committee, in its previous ad hoc form, created an approach for ecosystem research that takes into account the broad application and interdisciplinary nature of ecosystem research and establishes a set of research guidelines that ecosystem research in the agency should consider. Working with the spectrum of research entities through NOAA and its partners the project team is striving toward a connection and integration between ecological and social science research. The project team is using our process and approach as an example of how this research can be conducted.

In the interagency realm, NOAA continues to participate in the Federal Resource Management and Ecosystem Services (FRMES) project, which brings together federal agencies and outside expertise to share ideas and build a consistent approach to integrating ecosystem services into federal resource management and planning processes.

NOAA also continues to support the Ecosystem Services Working Group. With the addition of Deputy Assistant Secretary Mark Schaefer, the prominence and effectiveness of this group has greatly increased. Dr. Schaefer has been a long time supporter of ecosystem services work and he has raised the bar in terms of applicability and actions. Through the CSC project team member, the project has come to Dr Schaefer's attention on several occasions and will continue to.

The goal of the Ecosystem Services Working Group is to act as a point of contact and a coordinating body for ecosystem services work at the agency. The group continues to be a great point of contact for outreach to those working in the area of ecosystem services NOAA and their respective constituencies.

Project team member, Pete Wiley continues to participate in each of these processes and strives to enhance the usefulness and raise the visibility of the project as an example of how this kind of research should be conducted.

The NERRS System continues to be interested in pursuing ecosystem services work as evidenced in the latest NERRS Annual Meeting, which includes a "Get Creative" session in which participants discussed a way forward in terms of coordinating this work across the system, how best to communicate this work – within the system and to target audiences, and how to best fund this work.

E. Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.

Team Collaborations expanding to Maine and New Hampshire EPSCoR Sustainability Science projects and Sea Grant
Interdisciplinary collaborative research engenders both rewards and challenges. The research team for this project acknowledges and shares both among the team and with outside stakeholders interested in the progress of the project. Through Wells NERR involvement in the Maine Sustainable Solutions Initiative (SSI), coordinated through the University of Maine, and Rob Johnston's professional relationship with U Maine economics faculty, linkages have been made between the Sustaining Coastal Landscapes project and SSI. Maine SSI uses sustainability science as an organizing principle for the suite of projects funded by a five year NSF EPSCoR grant. The NSC collaborative research approach shares process elements with sustainability science, but this connection between research paradigms has not been recognized or documented formally. Bringing the literature of sustainability science, which is closely tied to ecosystem and community resilience literature, into discussions and evaluation of the impacts of NSC research could be beneficial in documenting the impacts of funded project.

Research collaborations are emerging from this project as a result of relationships developed during the past three years. Dr. Johnston received Sea Grant funding to look at impacts on real estate markets in response of coastal storms. New England NERRS are collaborators on that proposal for stakeholder engagement practices.

Maine SSI in collaboration with NH EPSCoR received a Track II NSF grant focusing on coastal water quality as it impacts shellfish and beaches. . Drs Kalle Matso of NSC and Chris Feurt of Wells NERR/UNE are collaborators on that grant. There will be opportunities to link NERRS research approaches with a broader NSF focused academic audience through this work over the next three years.

Connections to Maine Stream Connectivity Efforts

Jacob Aman has identified connections for the project with Maine efforts to foster stream connectivity. We are capturing some of Jacob's key ideas here to document future actions for the Wells NERR project team.

The Maine Stream Connectivity Work Group is a process that I am trying to stay involved with as it ties us in to a network of resource people and funding directly related to the stream habitat restoration work we have been doing over the last few years. This report shares the accomplishments and goals of the group. Please note that our data is

included in this report (road crossing graph, Kennebunk River) and our organization is listed as a participant (last page).

Of interest in the report is a literature citation for a study of the economic benefits of restoration. I don't have access to the full paper, but here is the abstract:

http://www.sciencedirect.com/science/article/pii/S0308597X12001182

and also some gray literature based on these findings:

http://www.conservationgateway.org/Documents/8_Restoration%20Jobs%20Per%20Investment_0.pdf

http://www.habitat.noaa.gov/pdf/tnc_noaa_arra_restoration_summary.pdf

Habitat Assessment 2013

- Data are arrange in the same manner as previous years
- Stream velocity measurement protocols were not followed for sites 2A, 2B, 3A, and 9A. The wetted widths at these sites being greater than 3.96 meters required velocity measurements every .91m, however measurements were only taken at ¼, ½, and ¾ wetted width. Discharge calculations have still be made.
- All length and depth measurements are in meters.

E-Fishing Surveys 2011-2013

I have combined all data for 2011-2013 to make it easier to access and work with. In addition, I have added entries for all of the "escaped fish" so that the data works better in a pivot table. During the process of combining the data from all three years, I noticed a few things that need updating in the previous two years data, and so I have made the appropriate edits to the data in this new workbook. This mostly represents formatting for times to all be in military time, removal of salinity, and removal of notes related to non-existent weather observations. The following notes apply to all three years data unless specifically noted:

- 2013 Data were not collected at site 3 due to high water depths that prevented safe operation of electrofishing equipment.
- Basic fish metrics and reach area calculations are included on a separate sheet in the workbook.
- Escaped fish were included in species richness and density calculations.
- Due to uncertainty about the identification of pearl dace and lake chubs, all of these entries have been change to the family level ID Cyprinidae, with the original identification recorded in the Comments 2 column in case it is need.

Nitrogen 2011 - 2013

- Workbook contains all data from 2011 – 2013.
- Daily absorption rates have been calculated for both NO3- and NH4
- Weight measurements for resin beads have been included for pre and post deployment.

Macro-invertebrate IBI 2011, 2012, 2013

- IBI were adjusted to include all families from all three years.
- The species tolerance values and feeding groups for the IBI were obtained from the EPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish - Second Edition

Appendix B, located here:
http://water.epa.gov/scitech/monitoring/rsl/bioassessment/

- Taxonomic Serial Numbers were obtained from the Integrated Taxonomic Information System: http://www.itis.gov/
- Class Cnidaria has no listed tolerance values. 2013 samples include 1 species, Anthomedusae Hydractiniidae
- Order Bassomatophora has several family tolerances. No family is specified, so tolerance value is a range, and has not been included. The feeder group was available and is included.
- Rhynchobdellida Piscicolidae. This family does not have an available tolerance value, but the sub-class does, and both the tolerance value and the feeder group was used.
- Hemiptera Notonectidae does not have an available tolerance value at the Family or Order level.
- Trichoptera sp. Does not have a tolerance value or a feeding group.
- It was decided not to include any individuals that were not identified to the family level if more than one family is present in any given order. This will prevent error for the metrics that use number of families (e.g. EPT ratio). This applied to site 3B in 2011 only.
- Several errors were found in the formulas for the original IBI worksheet. These errors are:
  - An error was found in the IBI scoring formula for taxa richness, where the formula that assigns a "0" score included an "<" instead of an ">".
  - An error was found in the IBI scoring formula for community loss, where the formula that assigns a score of "3" was reading "<=0.5, >=4" but should be reading ">=0.5, <=4".
  - The column for "Is sample at both sites" included a formula that returns a positive value even if the entry for a site is "0". I changed the formula to recognize zeros, precluding the need to change any zero data to "blank", and it now returns a "1" only if neither of the compared cells contains a zero
  - The formulas for ai, bi, and min(ai,bi) were not entered for all rows, but this has now been corrected
- We continued to exclude the FC/SC metric if either of the groups was absent from a sample. If this occurred the IBI score was based on a total possible score of 48, rather than 54. It is unclear if this is the proper way to address this circumstance.
  - Sites that did not include the FC/SC metric in the DEPref IBI score: 2013 (7A), 2012 (2A,2B), 2011 (1A,1B,2B,7A,8A,9A,9B)
  - Sites that did not include the FC/SC metric in the A-B IBI score: 2013 (7B), 2012 (2B), 2011 (1B,2B,7B,8B,9B)
- Once all the corrections were made to the IBI for each year, new scores were generated. It appears that the scores 2012 were originally calculated incorrectly

due to the errors listed above. Sites for which the score changed include: DEPref (1B, 2A, 2B, 3A, 3B, 8A, 8B); A-B (1B, 2B, 3B, 7B, 8B, 9B)

In-situ Water Quality

- No   measurements were collected at site 4B, for unknown reasons. Logger was continuously deployed and seems to have stopped reading measurements for site 4B only.

Periphyton

- Workbook contains data for 2013 only and is arranged in approximately the same manner as previous years.
- Dilution factors have been included where necessary for samples that were at concentrations beyond detection range for the fluorometer.
- Mean CIA concentrations and standard deviation and error are calculated on a separate sheet in the workbook.
- Periphyton collectors were not recovered from site 9A, and only one was recovered from site 9B due to the likelihood of having been buried in sand, which is abundant at these sites.

Conference on Ecological and Ecosystem Restoration 2014
Dedicated Session Accepted

Title:
Sustaining Coastal Landscapes and Community Benefits: Developing a national interdisciplinary model for increasing the impact of scientific research on decision-making and policy to conserve ecosystem services in National Estuarine Research Reserves.

Summary:
This session presents interdisciplinary approaches to valuing ecosystem services associated with riparian buffers as a model for collaborative research that increases the impact of science on decision-making and policy. Ecological, economic, mental modeling methods and a communication audit were integrated with a multi-stakeholder engagement process to model a new approach to research in the National Estuarine Research Reserve System (NERRS). Riparian buffers and wetlands are a nexus for complex land use challenges where tradeoffs for ecosystem services must be evaluated. Coveted by developers and home owners, people and property in these areas are vulnerable to flooding, shoreline erosion and sea level rise. Natural buffers have water quality value for their ability to effectively filter nonpoint source pollution and are the last line of defense for stormwater runoff to estuaries. Ecologists recognize and value riparian habitats for their complex roles in nutrient cycling and biodiversity. Although the sensitivity of ecosystem services to changes in riparian land use is unquestioned, the quantification of associated spatially-explicit human benefits and tradeoffs, as well as the use of resulting information to guide policy, is often hindered by methodological gaps between economic approaches though which ecosystem services are defined and valued and ecological paradigms through which ecosystem processes are modeled. This model of collaborative research was developed to address these challenges.

Description:

This session examines the barriers to transdisciplinary research in the context of a national system of marine protected areas. The National Estuarine Research Reserve System (NERRS) is uniquely positioned to test, implement and evaluate the application of transdisciplinary research that integrates quantitative information on ecosystem service values and tradeoffs at a scale appropriate to improve decision-making. This research, conducted with the Wells NERR in Wells, Maine is developing an innovative model for transdisciplinary research integrating ecological, economic and communication research methodologies. Riparian ecosystem structure and function are being modeled using the ecological methods of the Index of Biological Integrity (IBI). The economic methodology of a choice experiment is being used to define and value riparian ecosystem services. A mental models approach is being used to assess stakeholder understanding of ecosystem services and tradeoffs and to develop explicit strategies for bridging communication barriers between academics of different disciplines and practitioners. This research is being conducted collaboratively with a diverse group of local stakeholders whose management objectives for conservation and restoration include sustaining riparian ecosystem services. This stakeholder group will use the results of this research to improve messages and

dialogues about trade-offs to policy makers and constituent groups. The local, state and federal agencies, watershed groups and land trusts in this stakeholder group approach their work through a predominantly biophysical lens with incomplete understanding of the theories, methodologies and frameworks applied by ecological economists. This research aims to open that lens to include an economic perspective.

At a national scale this research builds upon the ecological and communication strengths of the NERRS and addresses gaps in the application and integration of socio-economic approaches to improve the impact of NERRS science on decision-making for riparian and wetland area management, including policy processes and decisions influencing land use, habitat and nonpoint source pollution. Challenges associated with integrating economic frameworks and methodologies within the dominantly ecological perspectives of the NERRS and local stakeholders will be the focus of this session from the perspectives of each team member engaged in the four year project.

Intended Audience:

The intended audience is managers, restoration practitioners, researchers, and others interested in ecosystem service valuation, interdisciplinary approaches to ecological restoration and effective multi-stakeholder engagement directed toward sustaining or restoring ecosystem structure and function and enhancing community resilience. Participants will have an opportunity to interact with team members who will share the perspectives of the researchers, managers, policy makers and practitioners involved in the National Estuarine Research Reserve System approach to collaborative research and restoration.

Session Organizer:
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Qualifications of Organizer:
Dr. Christine Feurt works to sustain and restore linked social-ecological systems through the design and implementation of collaborative interdisciplinary projects. Christine has developed a method using Collaborative Learning to engage stakeholders with diverse perspectives and missions to improve the application of science to decision-making and policy. She has worked for the past 10 years in coastal watersheds in the Gulf of Maine with the Wells National Estuarine Research Reserve. Christine has been on the faculty of the University of New England and Director of the Center for Sustainable Communities for over 15 years focusing her work on sustainability science and undergraduate engagement with her research. Christine received her Ph.D. in Environmental Studies from Antioch University New England where her research focused on the use of cultural models and Collaborative Learning to implement Ecosystem Based Management.

CHALLENGES AND REWARDS OF TRANSDISCIPLINARY COLLABORATION TO SUSTAIN ECOSYSTEM SERVICES

Christine Feurt[1], Robert Johnston[2], Verna DeLauer[3] and Kristin Wilson[4]
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This research examines the barriers to transdisciplinary research in the context of a national system of marine protected areas, the National Estuarine Research Reserve System (NERRS). The Sustaining Coastal Landscapes and Community Benefits project based at the Wells, Maine NERR, developed and tested approaches to valuing ecosystem services associated with riparian buffers as a model for collaborative research that increases the impact of science on decision-making and policy. Ecological, economic, mental modeling methods and a communication audit were integrated with a multi-stakeholder engagement process to model a new approach to research in the NERRS. The NERRS is uniquely positioned to test, implement and evaluate the application of transdisciplinary research that integrates quantitative information on ecosystem service values and tradeoffs at a scale appropriate to improve decision-making. Although the sensitivity of ecosystem services to changes in riparian land use is unquestioned, the use of resulting information to guide policy, is often hindered by methodological gaps between economic approaches though which ecosystem services are defined and valued and ecological paradigms through which ecosystem processes are modeled. This model of collaborative research was developed to address these challenges.

This research project was conducted collaboratively with a diverse group of local stakeholders whose management objectives for conservation and restoration include sustaining riparian ecosystem services. This stakeholder group will use the results of this research to improve messages and dialogues about trade-offs to policy makers and constituent groups. The local, state and federal agencies, watershed groups and land trusts in this stakeholder group approach their work through a predominantly biophysical lens with incomplete understanding of the theories, methodologies and frameworks applied by ecological economists. This research opened that lens to include an economic perspective.

At a national scale this research builds upon the ecological and communication strengths of the NERRS and addresses gaps in the application and integration of socio-economic approaches to improve the impact of NERRS science on decision-making for riparian and wetland area management, including policy processes and decisions influencing land use, habitat and nonpoint source pollution. Challenges and benefits associated with integrating economic frameworks and methodologies within the dominantly ecological perspectives of the NERRS and local stakeholders will be the focus of this presentation.

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ECOLOGICAL ASSESSMENT OF RIPARIAN BUFFER STRUCTURE AND FUNCTION TO ASSESS ECOSYSTEM SERVICES

Michele Dionne[1], **Kristin R. Wilson[1]**, Chris R. Peter[2], Christine Feurt[1,3], Jacob Aman[1], Tin Smith[1]

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Vegetated, riparian buffers enhance stream biodiversity and water quality by regulating inputs of light, organic matter, sediment and nutrients. The delivery of these ecosystem services is spatially explicit, however and may affect their associated societal value. This study examines stream biophysical parameters at sites along two streams (Branch Brook, Merriland River) in one southern Maine watershed that differ in riparian buffer quality (buffered versus open, designated as such apriori). To assess physical stream conditions at each site, in 2011, 2012, and 2013 we recorded water temperature, pH, specific conductance, dissolved oxygen, turbidity, NO^{3-}, percent aquatic vegetative cover, stream bed percent cover, substrates, stream width and depth, stream gradient, velocity, discharge, in-stream large woody debris, bank condition, spawning gravel areas and the locations of pools/riffles/runs and pool quality. To quantify buffer quality, we recorded stream bank percent vegetated cover, air temperature, canopy cover, and soil nutrients (NO^{3-} and NH^{4+} using resin bags). To characterize biotic communities in stream reaches, we measured epibenthic algae using tiles, macroinvertebrate species composition using rock collection bags, and fish composition, abundance, and biomass via electronic fishing techniques. Biotic indices, univariate and multivariate tests including PRIMER were used to compare biophysical conditions between buffer quality as well as streams across years.

Preliminary analyses of the first two years of data reveal no major differences by buffer type across years for any biophysical parameter measured. Rather, the greatest differences occurred between streams. Averaged across years, the Merriland River had significantly more large woody debris per reach, significantly less sand in its stream bed, and significantly more percent trees in its adjacent stream banks than Branch Brook. Biotic data show that both streams had comparable epibenthic algae and macroinvertebrate communities (as revealed by t-tests using indices of biological integrity (Rapid Bioassessment Protocol II)), though fish communities differed. Averaged across years, the Merriland River had significantly fewer fish, a significantly lower coldwater index of biological integrity, and significantly fewer brook trout (*Salvelinus fontinalis*) than Branch Brook. Together, these data suggest that differences in buffer quality are not as important as between stream differences in this southern Maine watershed. These ecological data may inform interpretations of residents' economic valuation of riparian habitats and their mental models of this important ecotone.

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Verna DeLauer-Using Mental Modeling and Communication Audits to Link Ecosystem Service Valuation to Restoration Goals

Stakeholder groups responsible for managing and restoring riparian buffer structure and function have limited economic information on the value of these systems. Local, state and federal agencies, watershed groups and land trusts in this stakeholder group approach their work through a predominantly biophysical lens with incomplete understanding of the theories, methodologies and frameworks applied by ecological economists. This research aims to open that lens to include an economic perspective. A mental models approach and communications audit was used to assess stakeholder understanding of ecosystem services and tradeoffs and to develop explicit strategies for bridging communication barriers between academics of different disciplines and practitioners. This research was conducted collaboratively with a diverse group of local stakeholders whose management objectives for conservation and restoration include sustaining riparian ecosystem services. A grounded theory approach using focus groups, participant observation, qualitative interviews and a regional survey revealed dominant themes related to private property rights, a stewardship ethic, and disparities in values related to land tenure. Adapting the current narrative used by managers to reflect this new understanding of constituent groups values and attitudes is being used to improve messages and dialogues about trade-offs to policy makers.

Interdisciplinary Panel & Audience Engagement - Benefits and barriers of ecosystem service valuation for ecosystem restoration practice and policy

Riparian buffers and wetlands are a nexus for complex land use challenges where tradeoffs for ecosystem services must be evaluated. Ecological, economic, mental modeling methods and a communication audit were integrated with a multi-stakeholder engagement process to model a new approach to research in the National Estuarine Research Reserve System (NERRS). Although the sensitivity of ecosystem services to changes in riparian land use is unquestioned, the quantification of associated spatially-explicit human benefits and tradeoffs, as well as the use of resulting information to guide policy, is often hindered by methodological gaps between economic approaches though which ecosystem services are defined and valued and ecological paradigms through which ecosystem processes are modeled. This model of collaborative research was developed to address these challenges. At a national scale this research builds upon the ecological and communication strengths of the NERRS and addresses gaps in the application and integration of socio-economic approaches to improve the impact of NERRS science on decision-making for riparian and wetland area management, including policy processes and decisions influencing land use, habitat and nonpoint source pollution. Challenges associated with integrating economic frameworks and methodologies within the dominantly ecological perspectives of the NERRS and local stakeholders will be the focus of this session from the perspectives of each team member engaged in the four year project.